U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of Airport Safety and Standards
Airport Engineering Division

800 Independence Ave., SW
Washington, DC 20591

June 1, 2004

Attached is Federal Aviation Administration (FAA) Draft Advisory Circular (AC) 150/5370-10B STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS, Parts I-IV, and Part IX. The current revision (AC 150/5370-10A) is undergoing a complete revision. Several draft documents consisting of individual Parts of the AC will be circulated for review, culminating with a revised AC at the end of 2004. Principal changes are noted by marks in the border of each page. Items included in this draft document are: Item P-402 and ne Item P-403.

This draft is available on the following FAA internet website:
http://www.faa.gov/arp/publications/acs/draftacs.cfm

Comments received no later than July 16, 2004 will be considered for inclusion in Part V of the final advisory circular.

Sincerely,

Rick Marinelli

Rick Marinelli
Manager, Airport Engineering Division

Attachment

U.S. Department
of Transportation

**Federal Aviation
Administration**

Draft Advisory Circular

NOT APPROVED FOR USE

Subject: STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS--Part V	**Date:** Draft **Initiated by:** AAS-100	**AC No:** 150/5370-10B **Change**

1. PURPOSE. This advisory circular (AC) provides standards for the construction of airports. Items covered in this draft include general provisions, earthwork, flexible base courses, rigid base courses, and drainage.

2. BACKGROUND. AC 150/5370-10A, is undergoing a complete revision. Several draft documents consisting of individual Parts of the AC will be circulated for review, culminating with a new AC at the end of calendar year 2004.

3. PRINCIPAL CHANGES. Principal changes are noted by marks in the border of each page. Items included in this document are: Item P-402 Porous Friction Course and new Item P--403 Plant Mix Bituminous Pavements.

David L. Bennett
Director, Office of Airport Safety and Standards

ITEM P-402 POROUS FRICTION COURSE

(Central Plant Hot Mix)

DESCRIPTION

402-1.1 This item shall consist of a plant mixed, open-graded (porous) friction course, composed of mineral aggregate and bituminous material, mixed in a central mixing plant, and placed on a prepared surface in accordance with these specifications and shall conform to the dimensions and typical cross section as shown on the plans.

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The porous friction course (PFC) is designed as a free draining wearing surface of uniform thickness. The PFC must be placed on a prepared surface, which drains freely and does not allow ponding. The PFC should not be applied over an existing PFC. Any existing PFC should be removed and the entire surface leveled prior to placement of a new PFC.

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MATERIALS

402-2.1 AGGREGATE. **The aggregate shall consist of crushed stone, crushed gravel, or crushed slag with or without other inert finely divided mineral aggregate. The aggregate shall be composed of clean, sound, tough, durable particles, free from clay balls, organic matter, and other deleterious substances. The portion of the material retained on the No. 4 sieve shall be known as coarse aggregate, the portion passing the No. 4 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.**

a. Coarse Aggregate. Crushed aggregate shall contain at least 75 percent by weight of crushed pieces having two or more fractured faces and 100 percent by weight of particles with one or more fractured faces. The area of each face shall be equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractures are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be obtained by crushing. The coarse aggregate shall not contain more than 8 percent, by weight of flat or elongated pieces as defined in ASTM D 693. The percentage of wear shall not be greater than 30 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 12 percent after five cycles, when tested in accordance with ASTM C 88.

b. Fine Aggregate. Fine aggregate shall have a plasticity index of not more than 6.0 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318. The percentage of wear shall not be greater than 30 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 12 percent after five cycles, when tested in accordance with ASTM C 88.

If necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

402-2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242. When mineral filler is required to be batched separately, hydrated lime in the amount of 1.5 percent maximum by weight of the total aggregate shall be batched as part of the added mineral filler. No additional compensation will be allowed the Contractor for furnishing and using hydrated lime or other approved mineral filler that may be required by this specification.

402-2.3 BITUMINOUS MATERIAL. **The bituminous material shall be viscosity graded asphalt cement meeting**

ASTM D-3381, Table 2. A synthetic rubber additive shall be added to the bitumen in an amount not less than 2 percent by weight (% by weight of synthetic rubber solids). The bitumen and additive shall be uniformly mixed to provide a mixture meeting the following requirements:

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PER CENTRAL REGION:

Table No. 1

Property	ASTM	Min.	Max.
Viscosity @ 140°F., Poises	D-2171	1600	2400
Viscosity @ 275°F., cSt.	D-2170	325	
Flash Point, °F.,	D-92	450	
Ductility @ 77°F (5 cm/min) cm.	D-113	100	
Ductility @ 39.2°F (5 cm/min) cm.	D-113	50	
Toughness, inch-pounds	*	110	
Tenacity, inch-pounds	*	75	
Thin Film Oven Test:			
Tests on Residue			
Viscosity @ 140°F., Poises	D-2170	--	3000
Ductility @ 77°F., (5 cm/min) cm	D-113	100	
Ductility @ 39.2°F., (5 cm/min) cm	D-113	25	

* Benson Method of Toughness and Tenacity: Scott Tester, inch-pounds @ 77°F., 20 inches per minute pull. Tension head seven eighths inch diameter.

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PER NORTHWEST REGION:

Table No. 1

Property	ASTM	Min.	Max.
Viscosity @ 140°F., Poises	D-2171	1600	
Viscosity @ 275°F., cSt.	D-2170	325	
Flash Point, °F.,	D-92	450	
Ductility @ 77°F (5 cm/min) cm.	D-113	100	
Ductility @ 39.2°F (5 cm/min) cm.	D-113	50	
Toughness, inch-pounds	ASTM D 5801	110	
Tenacity, inch-pounds	ASTM D 5801	75	
Thin Film Oven Test:			
Tests on Residue			
Viscosity @ 140°F., Poises	D-2170		8000
Ductility @ 77°F., (5 cm/min) cm	D-113	100	
Ductility @ 39.2°F., (5 cm/min) cm	D-113	25	

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Certified test results plus a sample of the bitumen-synthetic rubber mixture shall be provided for each tank load shipped to the project or for each mixed batch, whichever is smaller. Samples being tested shall contain the anti-stripping additive. No material shall

be used before the test results are delivered to the Engineer. The Engineer will conduct independent acceptance tests on some samples. Material placed which does not meet the specification requirements shall be removed and replaced at no additional cost to the owner. A temperature-viscosity curve for the material shall be provided to the Engineer.

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Samples shall be taken, however a minimum of one sample shall be tested by the Engineer to verify the submitted certification. Additional samples shall be tested if results are borderline or for any other reason. The initial test is recommended to be done early in the project.

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COMPOSITION

402-3.1 COMPOSITION OF MIXTURE. The porous friction course shall be composed of aggregate, filler, bituminous material-synthetic rubber mixture, and anti-stripping agent.

402-3.2 JOB MIX FORMULA. No bituminous mixture shall be produced for payment until the Engineer has given written approval of the job mix formula. The job mix shall be prepared by a laboratory at the Contractor's expense. The job mix formula shall remain in effect for the duration of the project. The job mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, the amount of anti strip agent to be added (minimum of one half of one percent by weight), and a single temperature for the mixture as it is discharged into the hauling units. Silicone can be added to the mixture at a maximum rate of 1 once per 5,000 gallons of asphalt to facilitate laydown and rolling. Proper asphalt content shall be determined by mixing trial batches in the laboratory.

The job mix shall be submitted to the Engineer at least [30] days prior to the start of paving and shall include:

a. Percent passing each sieve size.
b. Percent of asphalt cement.
c. Asphalt viscosity or penetration grade.
d. Mixing temperature.
e. Temperature of mix when discharged from the mixer.
f. Temperature viscosity relationship of the asphalt cement.
g. Percent of wear (LA abrasion).
h. PI of fine aggregate.
i. Percent fractured faces.
j. Percent elongated particles.
k. Anti-strip agent.

The Contractor shall submit samples to the Engineer, upon request, for job mix formula verification testing.

The combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation shown in Table 2 when tested in accordance with ASTM C 136.

The gradations in Table 2 represent the limits, which determine the suitability of the aggregate for use from the source of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 2 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

Table 2. Aggregate-Porous Friction Course

Percentage by Weight Passing Sieves

Sieve	3/4" maximum	1/2" maximum	Job-Mix (Production) Tolerances **
3/4"	100	---	---
1/2"	70-90	100	+/- 5%
3/8"	40-65	85-95	+/- 5%
#4	15-25	30-45	+/- 5%
#8	8-15	20-30	+/- 2%
#30	5-9	9-17	+/- 2%
#200	1-5	2-7	+/- 2%
Bitumen			+/- 0.2%
Temperature of Mix			+/- 20 degrees F.

** The gradation job mix tolerance limits shall will apply if they fall outside the master grading band in Table 2 except for the top two sieve sizes starting at the 100% passing band. These two sieve size bands shall also be additional limits for production.

The gradations shown are based on aggregates of uniform specific gravity, and the percentages passing the various sieves will be subject to appropriate adjustments by the Engineer when aggregates of varying specific gravities are used. The adjustments to the job mix gradation curve should result in a curve of the same general shape as the median curve of the gradation band in Table 2 and fall within the gradation band.

The Asphalt Institutes Manual Series No. 2 (MS-2) contains a convenient procedure for "adjusting" the job mix gradation when aggregates of non uniform specific gravity are proposed for use.

The bituminous content of porous friction courses shall be expressed as a percentage of the total mix by weight and shall be approved by the Engineer on the basis of laboratory tests. The materials used in the mix design shall be the same as those used on the project.

The bituminous content shall be within plus or minus 1 percent of the value obtained from the formula:

$$2K_c + 4.0$$

where K_c is the surface area constant for that part of the total dry aggregate that will pass a 3/4" (19.0 mm) sieve and be retained on the No. 4 (4.75 mm) sieve. Procedures for determining K_c are contained in the Asphalt Institute's Manual Series No. 2 (MS-2). The bituminous content so estimated is the percentage by weight of the total dry aggregates and must be converted to the percent by weight of the total mix in the approved job-mix formula.

The laboratory used to develop the job mix formula shall meet the requirements of ASTM D 3666. A certification signed by the lab manager of the laboratory stating that it meets these requirements shall be submitted to the Engineer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
b. A listing of equipment to be used in developing the job mix.
c. A copy of the laboratory's quality control system.
d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

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Note: The AC content should be adjusted during the test section. One method to establish the optimum AC content is with the use of a glass dish. Various AC content mixes are made in increments of 0.5% (5.5%, 6.0%, 6.5%, etc.). The mix that will completely cover the bottom of the dish should be used to start the test strip. The AC content should then be increased in the test strip until it starts to bleed. The content then is decreased by 0.5%.

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402-3.3 TEST SECTION. **No bituminous mixture shall be produced for payment prior to successful placement of and acceptance of a test strip by the Engineer. At least one full day prior to full production, the Contractor shall prepare a quantity of bituminous mixture according to the approved job mix formula. The amount of mixture should be sufficient to construct a test section at least 50 feet long and 20 feet wide, placed in two sections and of the same depth specified on the plans. The test area will be designated by the Engineer. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.**

If the test section should prove to be unsatisfactory, the necessary adjustments to plant operation, and/or placement procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When the test section does not conform to specification requirements, the test section shall be removed and replaced at the Contractors expense. Full production shall not begin without approval of the Engineer. Test sections, which conform to specification requirements, shall be measured and paid in accordance with Paragraphs 402-5.1 and 402-6.1. The asphalt content may be adjusted by the Engineer during the test section and will be used as the target asphalt content.

CONSTRUCTION METHODS

402-4.1 WEATHER AND SEASONAL LIMITATIONS. The porous friction course shall be constructed only on a dry surface when the atmospheric temperature is 50 F (10 C) and rising (at calm wind conditions) and when the weather is not foggy or rainy.

402-4.2 BITUMINOUS MIXING PLANT. Plants used for the preparation of bituminous mixtures shall conform to the requirements of ASTM D 995 with the following changes:

a. Requirements for all Plants.

(1) Truck Scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor, or on public scales at the Contractor's expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of Section 90.

(2) Testing Laboratory. The Contractor or producer shall provide laboratory facilities for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

(3) Inspection of Plant. The Engineer, or his/her authorized representative, shall have access, at all times, to all parts of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

(4) Storage Bins and Surge Bins. Paragraph 3.9 of ASTM D 995 is deleted.

402-4.3 HAULING EQUIPMENT. **Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. The truck beds shall be raised to drain any excess solution before loading the mixture in the trucks. Each truck shall have a suitable cover to protect the mixture from adverse weather. If conditions warrant, truck beds shall be insulated and covers shall be securely fastened so that the mixture will be delivered to the site at the specified temperature.**

402-4.4 BITUMINOUS PAVERS. **Bituminous pavers shall be self-contained, power-propelled units with an activated screen or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant-mix material which will meet the specified thickness, smoothness, and grade.**

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required smoothness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

Pavers shall be equipped with an automatic grade control system capable of automatically maintaining the screen elevation as specified herein. The control system shall be automatically activated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devises which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

The controls shall be capable of working in conjunction with any of the following attachments:

- **(a) Ski-Type device of not less than 30 feet in length or as directed by the Engineer.**
- **(b) Taut stringline (wire) set to grade.**
- **(c) Short ski or shoe.**
- **(d) Laser controls.**

The controls shall be so arranged that independent longitudinal grade controls can be operated simultaneously on both sides of the machine or singly on either side. The electronic controls shall be arranged so that the machine can be controlled automatically, semi-automatically, or manually.

The automatic equipment shall be capable of controlling the grade to within plus or minus one-eighth inch and the transverse slope to within plus or minus one tenth of one percent from the controlling grade.

The machine shall be equipped with a spirit level or other type of slope indicator that will continuously indicate the average transverse slope of the screen. Curvature of spirit level tubes shall be as required to produce a bubble movement of not less than one-eighth inch for each one-tenth of one percent change in the transverse slope.

The paving machine shall be capable of being equipped with an infrared joint heater if directed by the Engineer. The output of infrared energy shall be in the one to six micron range. Converters shall be arranged end to end directly over the joint to be heated in sufficient numbers to continuously produce, when in operation, a minimum of 240,000 BTU per hour. The joint heater shall be positioned not more than one inch above the pavement to be heated and in front of the paver screed and shall be fully adjustable. Heaters will be required to be in operation at all times.

402-4.5 ROLLERS. **Rollers shall be steel wheel. Split drum rollers are not acceptable. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The wheels shall be equipped with adjustable scrapers and sprinkling apparatuses to prevent the bituminous mixture from sticking to the wheels. The number, type, and weight of rollers shall be sufficient to compact the mixture without detrimentally affecting the material.**

402-4.6 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated at the central mixing plant before entering the mixer. When introduced into the mixer, the combined aggregate moisture content (weighted according to the composition of the blend) shall be less than 0.25 percent for aggregate blends with water absorption of 2.5 percent or less and less than 0.50 percent for aggregate blends with water absorption greater than 2.5 percent. Water absorption of aggregates shall be determined by ASTM C 127 and C 128. The water absorption for the aggregate blend shall be the weighted average of the absorption values for the coarse aggregate retained on the No. 4 sieve (4.75 mm) and the fine aggregate passing the No. 4 sieve (4.75 mm). The water content test will be conducted in accordance with ASTM C 566. In no case shall the moisture content be such that foaming of the mixture occurs prior to placement. At the time of mixing, the temperature of the aggregate shall be within the range specified in the job mix formula. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. **Particular** care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The aggregate shall be screened to specified sizes and conveyed in separate bins ready for mixing with bituminous material.

402-4.7 PREPARATION OF BITUMINOUS MIXTURE. **The bituminous mixture shall be prepared in a central mixing plant. The mixture shall be prepared at the temperature designated by the mix design.**

The dry aggregate shall be combined in the plant in the proportionate amounts of each aggregate size required to meet the specified gradation. The quality of aggregate for each batch shall be determined, measured, and conveyed into the mixer.

The quantity of bituminous material for each batch or the calibrated amount for continuous mixers shall be determined by the certified laboratory that prepared the mix design. It shall be measured by weight and introduced into the mixer within the temperature range specified in the job mix formula. For batch mixers, all aggregates shall be in the mixer before the bitumen material is added. In no case shall the temperature of the aggregate be more than 25°F above the temperature of the bituminous material.

Mixing shall continue until all particles are coated uniformly. In no case shall the bituminous mixture be stored in storage silos or surge bins.

402-4.8 TRANSPORTATION AND DELIVERY OF THE MIXTURE. **The mixture shall be placed at a temperature between 250°F and 300°F. Loads shall be sent from the plant so that all spreading and compacting of the mixture may be accomplished during daylight hours. Excessive waiting or delay of haul trucks at the job site shall not be allowed; mix supplied at temperatures outside the specified range will not be accepted. Bleeding and rich spots resulting from segregation during transportation shall not be accepted.**

402-4.9 SPREADING AND LAYING. **Immediately before placing the porous friction course, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed. A tack coat conforming to Tack coat shall be placed on all existing surfaces for bonding the PFC to the existing surface. Placement of the PFC must be delayed until the tack coat has properly cured.**

The mixture shall be deposited from haul units directly into the laydown machine hopper and placed in a continuous operation.

Hauling over material already placed shall not be permitted until the material has been thoroughly compacted and allowed to develop stability for a period of at least 12 hours.

402-4.10 COMPACTION OF MIXTURE. **After spreading, rolling shall be done immediately. Two or four passes, at the discretion of the Engineer, with a steel wheel roller weighing no more than 10 tons, shall be made for compaction. Care should be taken to avoid over rolling or rolling when material is too cool. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but without excessive water. Rolling operations shall be conducted in such a manner that shoving or distortion will not develop. The amount of rolling shall be limited to only that necessary for consolidating the porous friction course and bonding it to the underlying surface course. Any mixture, which becomes loose, broken, mixed with dirt, or in any way defective, shall be removed and replaced with fresh mixture and immediately compacted to conform to the surrounding area. Such rework shall be done at the Contractor's expense. Spreading of the mixture shall be done carefully with particular attention given to making the operation as continuous as possible. Hand working shall be kept to an absolute minimum.**

Contractor quality control shall utilize a nuclear gauge to monitor compaction efforts.

402-4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The longitudinal joint shall offset that in the existing course by at least 1 foot (30 cm).

402-4.12 SHAPING EDGES. While the surface is being compacted and finished, the Contractor shall carefully shape the longitudinal outside edges of the PFC to a vertical face at the established edge. When transitioning from PFC to existing pavement, transverse edges shall be constructed with a finer graded bituminous mixture.

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Edge lips shall not exceed 3-inches; however, they are preferred to be less than 1.5-inches.
This may be a problem on projects that have excessive surface irregularities.
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402-4.13 SURFACE TESTS. **After completion of the final rolling, the finished surface shall be tested with a 12-foot straightedge and shall not vary more than 1/4 inch. The Contractor is responsible for supplying an acceptable metal 12-foot straight edge. The 12-foot straight edge shall be applied parallel with and at right angles to the runway centerline in a pattern that includes longitudinal and transverse joints. The 12-foot straightedge shall be advanced approximately 1/2 its length in the line of measurement. Areas of the porous friction course exceeding the specified tolerances shall be removed, as directed by the Engineer, and replaced with new material at the Contractor's expense. The Engineer shall immediately notify the Contractor of such unsatisfactory visual defects such as non-uniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture during rolling operations. Areas of the porous friction course, which possess such defects, shall be removed, as directed by the Engineer, and replaced with new material at the Contractors expense. Skin patching or hand working shall not be permitted.**

402-4.14 ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MATERIAL AND AGGREGATE.

The Engineer, at no cost to the Contractor, shall perform all acceptance sampling and testing. The testing organization performing the testing shall meet the requirements of ASTM D 3666.

Samples of the PFC mixture shall be taken at the point of discharge in hauling units and tested to control uniformity of bituminous content and gradation. Samples shall be taken in accordance with ASTM D 979.

Samples of the PFC mixture shall be taken at the point of discharge in hauling units and tested to control uniformity in tile bituminous content and gradation. Samples shall be taken in accordance with ASTM D 979 and prepared in accordance with ASTM D 2172 or ASTM D 6307. One sample shall be taken for each lot on a random basis in accordance with procedures contained in ASTM D 3665. A lot shall consist of 1,000 tons or 1/2 days production or whichever is less. Should the average bituminous content for any two consecutive lots not fall within job mix tolerances under 402-3.1, the Contractor shall cease production until such out-of-tolerance conditions have been remedied. Any material placed after the contractor has been informed of two consecutive failing tests shall be rejected and removed at the Contractor's expense.

Aggregate from each hot bin or aggregate feed shall be sampled on a random basis and tested for gradation analysis is according to ASTM C 136. One sample shall be taken on a random basis in accordance with ASTM D 3665 for each lot and a lot shall consist of 500 tons or 1/4 days production whichever is less. If any two consecutive samples fail to meet the tolerances of the job mix formula gradation, the Contractor shall cease plant production until such out-of tolerance conditions have been remedied. Any material placed after the contractor has been informed of two consecutive failing test shall be rejected and removed at the Contractor's expense.

The percent in place air voids shall be determined in accordance with ASTM D 2741.

The Engineer will notify the Contractor of unsatisfactory visual defects in the completed bituminous friction course such as non-uniform texture, roller marks, bleeding of bituminous material. Cracking and shoving of the mixture during the roller operations, or nonconformance to the surface smoothness criteria specified. Unsatisfactory bituminous friction course shall be removed and replaced at the Contractor's expense as directed by the Engineer.

402-4.15 BITUMINOUS AND AGGREGATE MATERIAL (CONTRACTOR'S RESPONSIBILITY). Samples of the bituminous and aggregate materials that the Contractor proposes to use, together with a statement of their source and character, shall be submitted for approval prior to use. The Contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials which have been tested and approved for the intended use shall be acceptable.

The Contractor shall furnish the vendor's certified test reports for each carload or equivalent of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted to use the material. The vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

402-4.16 PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cured at least 12 hours. Newly constructed pavement areas shall not be opened to aircraft traffic until 24 hours after completion or unless otherwise authorized by the Engineer.

METHOD OF MEASUREMENT

402-5.1 Porous friction course shall be measured by the number of **[square yards (square meters)][tons (kg)]** of mixture used in the accepted work.

Only the areas of the porous friction course meeting the following thickness requirements shall be measured for payment:

To determine the thickness of the finished PFC, the Engineer shall take one core sample, not less than 2 inches (5 cm) in diameter, at random from each unit of the completed PFC area. A unit of the completed area shall be one paving lane wide by 1,000 feet (304 m) long. The last unit in any one paving lane shall include any remaining length in addition to the 1,000 feet (304 m).

When the measurement of any core is more than the maximum or less than the minimum allowable thickness, as shown in Table 3, additional cores shall be taken at 20-foot intervals (6 m) (parallel to and at right angles to the runway centerline) until the completed PFC is within such maximum or minimum thickness for the subunit being tested. Out-of-tolerance areas shall be deducted from the total **[square yards (square meters)][tons (kg)]** PFC for payment. If, in the Engineer's judgment, such out of tolerance areas warrant removal, the PFC shall be removed and the underlying course shall be cleaned (ready for reconstruction), all at the Contractor's expense.

TABLE 3. ALLOWABLE FINISHED PFC THICKNESS

	Nominal		Maximum		Minimum	
	in.	mm	in.	mm	in.	mm
3/4 in. aggregate	1.0	25	1.50	37	0.75	19
1/2 in. aggregate	0.75	19	1.25	32	0.50	12

BASIS OF PAYMENT

402-6.1 Payment shall be made at the respective contract prices per **[square yard (square meter)][ton (kg)]** for porous friction course and per **[gallon (liter)][ton (kg)]** for bituminous material. The prices shall be full compensation for furnishing all materials; for all preparation and storage of materials; for cleaning the existing surface; for mixing, hauling, placing, and compacting the mixture (including initial test section); and for all tools, equipment, and incidentals necessary to complete each item. No separate payment is included in the contract for furnishing and batching mineral filler, or anti-stripping agents, should such items be required.

Rehabilitation of the existing pavement surface and the tack coat shall be measured and paid for at their respective contract prices.

Payment will be made under:

Item P-402-6.1	Porous Friction Course--**[per square yard (square meter)][ton (kg)]**
Item P-402-6.2	Bituminous material--**[per gallon (liter)][ton (kg)]**

TESTING REQUIREMENTS

ASTM C 88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	**Density,** Specific Gravity**,** and Absorption of Coarse Aggregate**s**
ASTM C 128	**Density,** Specific Gravity**,** and Absorption of Fine Aggregate
ASTM C 131	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 566	Total **Evaporable** Moisture Content of Aggregate by Drying

ASTM D 693	Crushed **Aggregate for** Macadam Pavements
ASTM D 979	Sampling Bituminous Paving Mixtures
ASTM D 995	**Mixing Plants for Hot-Mixed Hot-Laid Bituminous Paving Mixtures**
ASTM D 2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2741	**Susceptibility of Polyethylene Bottles to Soot Accumulation**
ASTM D 3665	**Random Sampling of Paving Materials**
ASTM D 3666	**Minimum Requirements for Agencies Testing and Inspecting Bituminuos Paving Materials**
ASTM D 4318	**Liquid Limit, Plastic Limit, and Plasticity Index of Soils**
ASTM D 6307	**Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method**

MATERIAL REQUIREMENTS

ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction

END OF ITEM P-402

ITEM P-403 PLANT MIX BITUMINOUS PAVEMENTS

DESCRIPTION

403-1.1 This item shall consist of a **[ ]** course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

* *

Specify base, and/or leveling course(s). Surface course may also be specified but only for those pavements designed to accommodate aircraft of gross weights less than or equal to 12,500 (5,670 kg) pounds or for surface course of shoulders, blast pads, service roads, etc. Item P-401 is to be specified for surface courses for pavements designed to accommodate aircraft gross weights greater than 12,500 (5,670) pounds.

This specification is to be used for pavements designed to accommodate aircraft of gross weights greater than 12,500 pounds (5,670 kg). State highway department specifications may be used in lieu of this specification for access roads, perimeter roads, stabilized base courses under Item P-501, and other pavements not subject to aircraft loading, or for pavements designed for aircraft gross weights of 12,500 (5,670) pounds or less.

Where a state highway department specification is to be used in lieu of this specification, the state specification must have a demonstrated satisfactory performance record under equivalent loadings and exposure. When a density requirement is not specified by a state specification, it is to be modified to incorporate the language found in paragraphs 403-5.1, 403-5.2 and 403-5.3.

* *

MATERIALS

403-2.1 AGGREGATE. Aggregates shall consist of crushed stone, crushed gravel, or crushed slag with or without natural sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 (4.75 mm) sieve is coarse aggregate. The portion passing the No. 4 (4.75 mm) sieve and retained on the No. 200 (0.075 mm) sieve is fine aggregate, and the portion passing the No. 200 (0.075 mm) sieve is mineral filler.

a. Coarse Aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating and bonding with the bituminous material and be free from organic matter and other deleterious substances. The percentage of wear shall not be greater than **[ ]** percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 10 percent, or the magnesium sulfate soundness loss shall not exceed 13 percent, after five cycles, when tested in accordance with ASTM C 88.

* *

Percentage of wear shall not exceed 40 for surface, binder, and leveling courses and 50 for base course. Aggregates with a higher percentage loss of wear or soundness may be specified in lieu of those indicated, provided a satisfactory service record under similar conditions of service and exposure has been demonstrated.

* *

Aggregate shall contain at least **[ ]** percent by weight of individual pieces having two or more fractured faces and **[ ]** percent by weight having at least one fractured face. The area of each face shall be equal to at least 75 percent of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be obtained by crushing.

* *

For pavement courses designed for aircraft gross weights of 60,000 pounds (27 200 kg) or more, the Engineer shall specify 70 percent for two fractured faces and 85 percent for one fractured face. For pavement courses designed for aircraft gross weights less than 60,000 pounds (27 200 kg), the Engineer shall specify 50 percent for two fractured faces and 65 percent for one fractured face.

In areas where slag is not available or desired, the references to it should be deleted from all aggregate paragraphs.

* *

The aggregate shall not contain more than a total of 8 percent, by weight, of flat particles, elongated particles, and flat and elongated particles, when tested in accordance with ASTM D 4791 with a value of 5:1.

* *

The Engineer may specify ASTM D 4791 with a ratio of 3:1. If so, replace the above paragraph as follows: "The aggregate shall not contain more than a total of 20 percent by weight of flat particles, elongated particles, and flat and elongated particles when tested in accordance with ASTM D4791 with a value of 3:1."

* *

Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 70 pounds per cubic foot (1.12 mg/cubic meter) when tested in accordance with ASTM C 29.

b. Fine Aggregate. Fine aggregate shall consist of clean, sound, durable, angular shaped particles produced by crushing stone, slag, or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The fine aggregate, including any blended material for the fine aggregate, shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

Natural (nonmanufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification. **[**The fine aggregate shall not contain more than 15 percent natural sand by weight of total aggregates.**]** If used, the natural sand shall meet the requirements of ASTM D 1073 and shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

The aggregate shall have sand equivalent values of **[ ]** or greater when tested in accordance with ASTM D 2419.

* *

Typically the sand equivalent value should be 45, unless local conditions require lower value.

The addition of natural sand to a mix containing all crushed coarse and fine aggregates will normally increase its workability and compactability. However, the addition of excessive amounts of natural sand tends to decrease the stability of the mixture. The requirement for

a sand equivalent value of 45 usually limits the use of natural sand; however, the maximum of 15 percent natural sand may be included for locations where low stabilities are a chronic problem.

* *

c. Sampling. ASTM D 75 shall be used in sampling coarse and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler.

403-2.2 MINERAL FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242.

403-2.3 BITUMINOUS MATERIAL. Bituminous material shall conform to the following requirements: **[ ]**.

* *

Asphalt cement binder shall conform to [AASHTO MP1 Performance Grade (PG) [_____]] [ASTM D 3381 Table 1, 2, or 3 Viscosity Grade][ASTM D 946 Penetration Grade [_____]]. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Engineer. The Engineer shall specify the grade of bituminous material, based on geographical location and climatic conditions. Asphalt Institute Superpave Series No. 1 (SP-1) provides guidance on the selection of performance graded binders. Table VI-1, Selecting Asphalt Grade, contained in the Asphalt Institute's Manual Series-1 (MS-1) provides guidance on the selection of asphalt type. For cold climates, Table 2 of ASTM D 3381 may be specified to minimize the susceptibility for thermal cracking. The Engineer should be aware that PG asphalt binders may contain modifiers that require elevated mixing and compaction temperatures that exceed the temperatures specified in Item P-403.

Grades of some materials are listed below:

NOTE: Performance Graded (PG) asphalt binders should be specified wherever available. The same grade PG binder used by the state highway department in the area should be considered as the base grade for the project (e.g. the grade typically specified in that specific location for dense graded mixes on highways with design ESALS less than 10 million). The exception would be that grades with a low temperature higher than PG XX-22 should not be used (e.g. PG XX-16 or PG XX-10), unless the Engineer has had successful experience with them. Typically, rutting is not a problem on airport runways. However, at airports with a history of stacking on end of runways and taxiway areas, rutting has accrued due to the slow speed of loading on the pavement. If there has been rutting on the project or it is anticipated that stacking may accrue during the design life of the project, then the following grade "bumping" should be applied for the top 125 mm (5 inches) of paving in the end of runway and taxiway areas: for aircraft tire pressure between 100 and 200 psi, increase the high temperature one grade; for aircraft tire pressure greater than 200 psi, increase the high temperature two grades. Each grade adjustment is 6 degrees C. Polymer Modified Asphalt, PMA, has shown to perform very well in these areas. The low temperature grade should remain the same.

Additional grade bumping and grade selection information is given in Table A.

Table A. Binder Grade Selection and Grade Bumping Based on Gross Aircraft Weight.

Aircraft Gross Weight (pounds)	High Temperature Adjustment to Base Binder Grade	
	Pavement Type	
	Runway	Taxiway/Apron
Less than 12,500	--	--
Less than 60,000	--	1
Less than 100,000	--	1
Greater than 100,000	1	2

NOTES:
1. PG grades above a –22 on the low end (e.g. 64–16) are not recommended. Limited experience has shown this to be a poor performer.
2. PG grades below a 64 on the high end (e.g. 58-22) are not recommended. These binders often provide tender tendencies.
3. PG grades above a 76 on the high end (e.g. 82-22) are not recommended. These binders are very stiff and difficult to work and compact.

Grade Specification			
Penetration Grade ASTM D 946	Viscosity Grade ASTM D 3381		Performance Graded Asphalt Institute Superpave Series No. 1(SP-1)
40-50 60-70 85-100 100-120 120-150	AC-5 AC-10 AC-15 AC-20 AC-30 AC-40	AR-1000 AR-2000 AR-4000 AR-8000	In general, the Engineer should choose a PG-asphalt binder that has been approved for use in the vicinity by the State DOT, and is locally available. In general, a high reliability (98 percent) on both the high and low temperature categories is sufficiently conservative.

* *

The Contractor shall furnish vendor's certified test reports for each lot of bituminous material shipped to the project. The vendor's certified test report for the bituminous material can be used for acceptance or tested independently by the Engineer.

403-2.4 PRELIMINARY MATERIAL ACCEPTANCE. Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

a. Coarse Aggregate.

(1) Percent of wear.
(2) Soundness.
(3) Unit weight of slag.

b. Fine Aggregate.

(1) Liquid limit.
(2) Plasticity index.

(3) Sand equivalent.

c. Mineral Filler.

d. Bituminous Material. Test results for bituminous material shall include temperature/viscosity charts for mixing and compaction temperatures.

The certification(s) shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirement.

The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

403-2.5 ANTI-STRIPPING AGENT. Any anti-stripping agent or additive if required shall be heat stable, shall not change the asphalt cement viscosity beyond specifications, shall contain no harmful ingredients, shall be added in recommended proportion by approved method, and shall be a material approved by the Department of Transportation of the State in which the project is located.

COMPOSITION

403-3.1 COMPOSITION OF MIXTURE. The bituminous plant mix shall be composed of a mixture of well-graded aggregate, filler and anti-strip agent if required, and bituminous material. The several aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

403-3.2 JOB MIX FORMULA. No bituminous mixture for payment shall be produced until a job mix formula has been approved in writing by the Engineer. The bituminous mixture shall be designed using procedures contained in Chapter 5, MARSHALL METHOD OF MIX DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete, sixth edition, and shall meet the requirements of Tables 1, 2 and 3.

* *

Engineer may specify the Eastern Region Laboratory Procedures Manual (ERLPM), Section 2 in lieu of MS-2.

* *

Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867, shall not be less than 75. Anti-stripping agent shall be added to the asphalt, as necessary, to produce a TSR of not less than 75. If an antistrip agent is required, it will be provided by the Contractor at no additional cost to the Owner.

* *

Engineer may specify a TSR of not less than 80 in areas that are prone to stripping at a TSR of 75.

* *

The job mix formula shall be submitted in writing by the Contractor to the Engineer at least **[ ]** days prior to the start of paving operations and shall include as a minimum:

a. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the job mix formula.

b. Percent of asphalt cement.

c. Asphalt performance, viscosity or penetration grade.

d. Number of blows of hammer compaction per side of molded specimen.

e. Mixing temperature.

f. Compaction temperature.

g. Temperature of mix when discharged from the mixer.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.

j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content.

k. Percent natural sand.

l. Percent fractured faces.

m. Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).

n. Tensile Strength Ratio (TSR).

o. Antistrip agent (if required).

The Contractor shall submit to the Engineer the results of verification testing of three (3) asphalt samples prepared at the optimum asphalt content. The average of the results of this testing shall indicate conformance with the job mix formula requirements specified in Tables 1, 2 and 3.

When the project requires asphalt mixtures of differing aggregate gradations, a separate job mix formula and the results of job mix formula verification testing must be submitted for each mix.

The job mix formula for each mixture shall be in effect until a modification is approved in writing by the Engineer. Should a change in sources of materials be made, a new job mix formula must be submitted within [ ] days and approved by the Engineer in writing before the new material is used. After the initial production job mix formula(s) has/have been approved by the Engineer and a new or modified job mix formula is required for whatever reason, the subsequent cost of the Engineer's approval of the new or modified job mix formula will be borne by the Contractor. There will be no time extension given or considerations for extra costs associated with the stoppage of production paving or restart of production paving due to the time needed for the Engineer to approve the initial, new or modified job mix formula.

* *

The Engineer shall specify the number of days. A minimum of 10 days is recommended.

For mixes with maximum size aggregate of 1" or less, the Marshall Design Criteria applicable to the project shall be specified by the Engineer from the information shown below and inserted into Table 1. Asterisks denote insert points.

Test Property	Pavements Designed for Aircraft Gross Weights of 60,000 Lbs. or More or Tire Pressures of 100 Psi or More	Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lbs. or Tire Pressures Less Than 100 Psi
Number of Blows	75	50
Stability, pounds (newtons)	1800 (8006)	1000 (4448)
Flow, 0.01 in. (0.25 mm)	8-16	8-20
Air Voids (percent)	2-5	2-5
Percent Voids in Mineral Aggregate (minimum)	See Table 2	See Table 2

For mixes with maximum size aggregate greater than 1 inch up to a maximum of 1-½ inches, the Marshall Design Criteria shall be modified by the Engineer per the guidance found in Asphalt Institute Manual Series No. 2 (MS-2), Chapter 5 and the test method specified shall be ASTM D 5581 in lieu of ASTM D 1559.

* *

TABLE 1. MARSHALL DESIGN CRITERIA

TEST PROPERTY	*
Number of blows	*
Stability, pounds (newtons) minimum	*
(newtons) minimum	
Flow, 0.01 in. (0.25 mm)	*
Air voids (percent)	*
Percent voids in mineral aggregate, minimum	See Table 2

TABLE 2. MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE

Maximum Particle Size		Minimum Voids in Mineral Aggregate, percent
in.	mm	Percent
½	12.5	16
¾	19.0	15
1	25.0	14
1-½	37.5	13

* *

Modifications to the minimum VMA as found in Table 2 may be made depending on the definition of maximum particle size and/or local conditions.

* *

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 3 when tested in accordance with ASTM C 136 and C 117.

The gradations in Table 3 represent the limits which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMF), shall have a gradation within the limits designated in Table 3 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine.

Deviations from the final approved mix design for bitumen content and gradation of aggregates shall be within the action limits for individual measurements as specified in paragraph 403-6.5a. The limits still will apply if they fall outside the master grading band in Table 3.

The maximum size aggregate used shall not be more than one-half of the thickness of the course being constructed except where otherwise shown on the plans or ordered by the Engineer.

TABLE 3. AGGREGATE - BITUMINOUS PAVEMENTS

Sieve Size	Percentage by Weight Passing Sieve
1-½ in. (37.50 mm)	*
1 in. (25.0 mm)	*
¾ in. (19.0 mm)	*
½ in. (12.5 mm)	*
⅜ in. (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 30 (0.60 mm)	*
No. 50 (0.30 mm)	*
No. 100 (0.15 mm)	*
No. 200 (0.075 mm)	*
Asphalt percent	
Stone or gravel	*
Slag	*

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute Manual Series No. 2 (MS-2), Chapter 3.

* *

The aggregate gradation shall be specified by the Engineer from the gradations shown in this note. The gradation shall be inserted into Table 3. Asterisks denote insert points.

Where locally-available aggregates cannot be economically blended to meet the grading requirements of the gradations shown, the gradations may be modified to fit the characteristics of such local aggregates with approval of the FAA. The modified gradation must produce a paving mixture that satisfies the mix design requirements.

AGGREGATE - BITUMINOUS PAVEMENTS				
Sieve Size	**Percentage by Weight Passing Sieves**			
	1-½" max	**1" max**	**¾ " max**	**½" max**
1-½ in. (37.5 mm)	**100**	**--**	**--**	**--**
1 in. (24.0 mm)	**86-98**	**100**	**--**	**--**
¾ in. (19.0 mm)	**68-93**	**76-98**	**100**	**--**
½ in. (12.5 mm)	**57-81**	**66-86**	**79-99**	**100**
⅜ in. (9.5 mm)	**49-69**	**57-77**	**68-88**	**79-99**
No. 4 (4.75 mm)	**34-54**	**40-60**	**48-68**	**58-78**
No. 8 (2.36 mm)	**22-42**	**26-46**	**33-53**	**39-59**
No. 16 (1.18 mm)	**13-33**	**17-37**	**20-40**	**26-46**
No. 30 (0.600 mm)	**8-24**	**11-27**	**14-30**	**19-35**
No. 50 (0.300 mm)	**6-18**	**7-19**	**9-21**	**12-24**
No. 100 (0.150 mm)	**4-12**	**6-16**	**6-16**	**7-17**
No. 200 (0.075 mm)	**3-6**	**3-6**	**3-6**	**3-6**
Asphalt percent:				
Stone or gravel	**4.5-7.0**	**4.5-7.0**	**5.0-7.5**	**5.5-8.0**
Slag	**5.0-7.5**	**5.0-7.5**	**6.5-9.5**	**7.0-10.5**

* *

403-3.3 RECYCLED ASPHALT CONCRETE. Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The recycled asphalt concrete mix shall be designed using procedures contained in the Asphalt Institute's Manual Series Number 2 (MS-2). The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D 2172 using the appropriate dust correction procedure. The job mix shall meet the requirements of paragraph 403-3.2 RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to **[ ]** percent.

* *

Reclaimed Asphalt Pavement (RAP) should not be used for surface mixes, except on shoulders. It can be used very effectively in lower layers or for shoulders. Engineer to specify the maximum percentage of reclaimed asphalt allowed in the mix. The amount of RAP shall be limited to 30 percent, as long as the resulting recycled mix meets all requirements that are

specified for virgin mixtures. The Contractor may obtain the RAP from the job site or an existing source.

* *

In addition to the requirements of paragraph 403-3.2, the job mix formula shall indicate the percent of reclaimed asphalt pavement and the percent and viscosity grade of new asphalt. The Contractor shall submit documentation to the Engineer, indicating that the mixing equipment proposed for use is adequate to mix the percent of RAP shown in the job mix formula and meet all local and national environmental regulations.

* *

The appropriate test should be selected to conform to the grade of new asphalt specified. If a penetration grade is specified, use penetration test. If a viscosity grade is specified, use a viscosity test. If a PG asphalt binder is specified, use the dynamic shear rheometer and bending beam tests.

* *

The blend of new asphalt cement and the RAP asphalt binder shall meet the requirements in paragraph 403-2.3. The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph 403-2.3

* *

Delete paragraph 403-3.3 in its entirety if recycled asphalt pavement is not to be allowed and include a sentence that RAP will not be permitted to be used.

* *

403-3.4 TEST SECTION. Prior to full production, the Contractor shall prepare and place a quantity of bituminous mixture according to the job mix formula. The amount of mixture shall be sufficient to construct a test section **[ ]** long and **[ ]** wide**,** placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint is an exposed construction joint at least 4 hours old or whose mat has cooled to less than 160^0 F. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

The test section shall be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 403-5.1 and 403-6.3. The test section shall be divided into equal sublots. As a minimum the test section shall consist of 3 sublots.

The test section shall be considered acceptable if the average mat density of the test section cores is greater than or equal to 98 percent and the average joint density of the test section cores is greater than or equal to 95 percent. If the initial test section should prove to be unacceptable, the necessary adjustments to the job mix formula, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that are not acceptable shall be removed at the Contractor's expense. Full production shall not begin until an acceptable section has been constructed and accepted in writing by the Engineer. Once an acceptable test section has been placed, payment for the initial test section and the section that meets specification requirements shall be made in accordance with paragraph 403-8.1.

Job mix control testing shall be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the job mix formula. If the aggregates produced by the plant do not satisfy the

gradation requirements or produce a mix that meets the JMF, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens shall be prepared and the optimum bitumen content determined in the same manner as for the original design tests.

* *

The test section should be a minimum of 300 feet (90 m) long and 20 to 30 feet (6 to 9 m) wide. The test section affords the Contractor and the Engineer an opportunity to determine the quality of the mixture in place, as well as performance of the plant and laydown equipment.

* *

403-3.5 TESTING LABORATORY. The Contractor's laboratory used to develop the job mix formula shall meet the requirements of ASTM D 3666 including the requirement to be accredited by a national authority such as the National Voluntary Laboratory Accreditation Program (NVLAP), the American Association for Laboratory Accreditation (AALA), or AASHTO Accreditation Program (AAP). A certification signed by the manager of the laboratory stating that it meets these requirements shall be submitted to the Engineer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

e. ASTM D 3666 certification of accreditation by a nationally recognized accreditation program.

CONSTRUCTION METHODS

403-4.1 WEATHER LIMITATIONS. The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the Engineer, if requested; however, all other requirements including compaction shall be met.

TABLE 4. BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperature (Minimum)	
	Deg. F	Deg. C
3 in. (7.5 cm) or greater	40	4
Greater than 1 in. (2.5 cm) but less than 3 in. (7.5 cm)	45	7
1 in. (2.5 cm) or less	50	10

403-4.2 BITUMINOUS MIXING PLANT. Plants used for the preparation of bituminous mixtures shall conform to the requirements of ASTM D 995 with the following changes:

a. Requirements for All Plants.

(1) Truck Scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor, or on certified public scales at the Contractor's expense. Scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of the General Provisions, Section 90-01.

In lieu of scales, and as approved by the Engineer, asphalt mixture weights may be determined by the use of an electronic weighing system equipped with an automatic printer which weighs the total paving mixture. Contractor must furnish calibration certification of the weighing system prior to mix production and as often thereafter as requested by the Engineer.

(2) Testing Facilities. The Contractor shall provide laboratory facilities at the plant for the use of the Engineer's acceptance testing and the Contractor's quality control testing. The Engineer will always have priority in the use of the laboratory. The lab shall have sufficient space and equipment so that both testing representatives (Engineer's and Contractor's) can operate efficiently. The lab shall also meet the requirements of ASTM D 3666.

The plant testing laboratory shall have a floor space area of not less than 150 square feet, with a ceiling height of not less than 7-½ feet. The laboratory shall be weather tight, sufficiently heated in cold weather, air-conditioned in hot weather to maintain temperatures for testing purposes of 70 degrees F +/- 5 degrees F. The plant testing laboratory shall be located on the plant site to provide an unobstructed view, from one of its windows, of the trucks being loaded with the plant mix materials.

Laboratory facilities shall be kept clean, and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

As a minimum, the plant testing laboratory shall have:

(a) Adequate artificial lighting
(b) Electrical outlets sufficient in number and capacity for operating the required testing equipment and drying samples.
(c) Fire extinguishers (2), Underwriter's approved
(d) Work benches for testing, minimum 2-½ feet by 10 feet.
(e) Desk with 2 chairs
(f) Sanitary facilities convenient to testing laboratory
(g) Exhaust fan to outside air, minimum 12 inch blade diameter
(h) A direct telephone line and telephone including a FAX machine operating 24 hours per day, seven days per week
(i) File cabinet with lock for Engineer
(j) Sink with running water, attached drain board and drain capable of handling separate material
(k) Metal stand for holding washing sieves
(l) Two element hot plate or other comparable heating device, with dial type thermostatic controls for drying aggregates
(m) Mechanical shaker and appropriate sieves (listed in JMF, Table 3) meeting the requirements of ASTM E-11 for determining the gradation of coarse and fine aggregates in accordance with ASTM C 136

(n) Marshall testing equipment meeting ASTM D 1559 or ASTM D 5581 as necessary, automatic compaction equipment capable of compacting three specimens at once and other apparatus as specified in ASTM C 127, D 2172, D 2726, and D 2041
(o) Oven, thermostatically controlled, inside minimum 1 cubic foot
(p) Two volumetric specific gravity flasks, 500 CC
(q) Other necessary hand tools required for sampling and testing
(r) Library containing contract specifications, latest ASTM volumes 4.01, 4.02,4.03 and 4.09, AASHTO standard specification parts I and II, and Asphalt Institute Publication MS-2.
(s) Equipment for Theoretical Specific Gravity testing including a 4,000 cc pycnometer, vacuum pump capable of maintaining 30 ml mercury pressure and a balance, 16-20 kilograms with accuracy of 0.5 grams
(t) Extraction equipment, centrifuge and reflux types and ROTOflex equipment
(u) A masonry saw with diamond blade for trimming pavement cores and samples
(v) Telephone

Approval of the plant and testing laboratory by the Engineer requires all facilities and equipment to be in good working order during production, sampling and testing. Failure to provide the specified facilities shall be sufficient cause for disapproving bituminous plant operations.

The Owner shall have access to the lab and at the plant whenever Contractor is producing asphalt for the project.

(3) Inspection of Plant. The Engineer, or Engineer's authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

(4) Storage Bins and Surge Bins. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:

(a) The bituminous mixture may be stored in surge bins for a period of time not to exceed 3 hours.
(b) The bituminous mixture may be stored in insulated storage bins for a period of time not to exceed 24 hours**.**

The bins shall be such that mix drawn from them meets the same requirements as mix loaded directly into trucks.

If the Engineer determines that there is an excessive amount of heat loss, segregation or oxidation of the mixture due to temporary storage, no temporary storage will be allowed.

403-4.3 HAULING EQUIPMENT. Trucks used for hauling bituminous mixtures shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

403-4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness,

smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

The controls shall be capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 30 feet (9.14 m) in length.

b. Taut stringline (wire) set to grade.

c. Short ski or shoe.

d. Laser control.

If, during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement and/or base course that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and satisfactory equipment shall be provided by the Contractor.

403-4.5 ROLLERS. Rollers of the vibratory, steel wheel, and pneumatic-tired type shall be used. They shall be in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.

All rollers shall be specifically designed and suitable for compacting hot mix bituminous concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used. Depressions in pavement surfaces caused by rollers shall be repaired by the Contractor at its own expense.

The use of equipment which causes crushing of the aggregate will not be permitted.

a. Nuclear Densometer. The Contractor shall have on site a nuclear densometer during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall also supply a qualified technician during all paving operations to calibrate the nuclear densometer and obtain accurate density readings for all new bituminous concrete. These densities shall be supplied to the Engineer upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

403-4.6 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be heated in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to

provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325 degrees F (160 degrees C), unless otherwise required by the manufacturer.

403-4.7 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be heated and dried prior to introduction into the mixer. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350 degrees F (175 degrees C) when the asphalt is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

403-4.8 PREPARATION OF BITUMINOUS MIXTURE. The aggregates and the bituminous material shall be weighed or metered and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until the aggregate obtains a uniform coating of bitumen and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95 percent of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all bituminous mixtures upon discharge shall not exceed 0.5 percent.

* *

For batch plants, wet mixing time begins with the introduction of bituminous material into the mixer and ends with the opening of the mixer discharge gate. Distribution of aggregate and bituminous material as they enter the pugmill, speed of mixer shafts, and arrangement and pitch of paddles are factors governing efficiency of mixing. Prolonged exposure to air and heat in the pugmill harden the asphalt film on the aggregate. Mixing time, therefore, should be the shortest time required to obtain uniform distribution of aggregate sizes and thorough coating of aggregate particles with bituminous material.

* *

403-4.9 PREPARATION OF THE UNDERLYING SURFACE. Immediately before placing the bituminous mixture, the underlying course shall be cleaned of all dust and debris. A prime coat or tack coat shall be applied in accordance with Item P-602 or P-603, if shown on the plans.

* *

Engineer should evaluate the presence of paint and rubber deposits on the existing pavement and, if needed, may specify milling, grinding or other suitable means to remove same prior to placement of new bituminous material.

* *

403-4.10 LAYDOWN PLAN, TRANSPORTING, PLACING, AND FINISHING. Prior to the placement of the bituminous mixture, the Contractor shall prepare a laydown plan for approval by the Engineer. This is to minimize the number of cold joints in the pavement. The laydown plan shall include the sequence of paving laydown by stations, width of lanes, temporary ramp location(s), and laydown temperature. The laydown plan shall also include estimated time of completion for each portion of the work (i.e. milling, paving, rolling, cooling, etc.). Modifications to the laydown plan shall be approved by the Engineer.

The bituminous mixture shall be transported from the mixing plant to the site in vehicles conforming to the requirements of paragraph 403-4.3. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

[The Contractor may elect to use a material transfer vehicle to deliver mix to the paver.**]**

* *

Use of a material transfer vehicle allows the paver to be operated almost continuously without stopping between truckloads of mix, if a continuous supply of mix is available from the asphalt plant.

* *

Paving during nighttime construction shall require the following:

a. All paving machines, rollers, distribution trucks and other vehicles required by the Contractor for his operations shall be equipped with artificial illumination sufficient to safely complete the work.

b. Minimum illumination level shall be twenty (20) horizontal foot candles and maintained in the following areas:

(1) An area of 30 feet wide by 30 feet long immediately behind the paving machines during the operations of the machines.

(2) An area 15 feet wide by 30 feet long immediately in front and back of all rolling equipment, during operation of the equipment.

(3) An area 15 feet wide by 15 feet long at any point where an area is being tack coated prior to the placement of pavement.

c. As partial fulfillment of the above requirements, the Contractor shall furnish and use, complete artificial lighting units with a minimum capacity of 3,000 watt electric beam lights, affixed to all equipment in such a way to direct illumination on the area under construction.

d. In addition, the Contractor shall furnish [ ] portable floodlight units similar or equal to [ ].

* *

Engineer to specify the minimum number of floodlighting units and may elect to specify a particular manufacturer's lighting unit "or equal".

If nighttime paving requires the critical re-opening of airfield facilities, the following additional language should be added:

"If the Contractor places any out of specification mix in the project work area, the Contractor is required to remove it at its own expense, to the satisfaction of the Engineer. If the Contractor has to continue placing non-payment bituminous concrete, as directed by the Engineer, to make the surfaces safe for aircraft operations, the Contractor shall do so to the satisfaction of the Engineer. It is the Contractor's responsibility to leave the facilities to be paved in a safe condition ready for aircraft operations. No consideration for extended closure time of the area being paved will be

given. As a first order of work for the next paving shift, the Contractor shall remove all out of specification material and replace with approved material to the satisfaction of the Engineer. When the above situations occur, there will be no consideration given for additional construction time or payment for extra costs."

* *

The initial placement and compaction of the mixture shall occur at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 250 degrees F (121 degrees C).

Edges of existing bituminous pavement abutting the new work shall be saw cut and carefully removed as shown on the drawings and painted with bituminous tack coat before new material is placed against it.

Upon arrival, the mixture shall be placed to the full width by a bituminous paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of **[ ]** except where edge lanes require less width to complete the area. Additional screed sections shall not be attached to widen paver to meet the minimum lane width requirements specified above unless additional auger sections are added to match. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course.

Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

* *

The Engineer should specify the widest paving lane practicable in an effort to hold the number of longitudinal joints to a minimum.

* *

403-4.11 COMPACTION OF MIXTURE. After placing, the mixture shall be thoroughly and uniformly compacted by power rollers. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be equipped with a scraper and kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power driven tampers. Tampers shall weigh not less than 275 pounds, have a tamping plate width not less than 15 inches, be rated at not less than 4,200 vibrations per minute, and be suitably equipped with a standard tamping plate wetting device.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

403-4.12 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, uncompacted, or otherwise defective **[**or which have been left exposed for more than 4 hours, or whose surface temperature has cooled to less than 160^0 F**]** shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The cost of this work and tack coat shall be considered incidental to the cost of the bituminous course.

* *

Engineer may retain the bracketed language regarding the treatment of "cold joints" when considered necessary.

* *

MATERIAL ACCEPTANCE

403-5.1 ACCEPTANCE SAMPLING AND TESTING. Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated by the testing organization prior to the start of operations.

a. Field Placed Material. Material placed in the field shall be tested for mat and joint density on a lot basis. A lot will consist of:

- one day or shift's production not to exceed 2,000 tons (1 814 000 kg), or

- a half day or shift's production where a day's production is expected to consist of between 2,000 and 4,000 tons (1 814 000 and 3 628 000 kg), or

- similar subdivisions for tonnages over 4,000 tons (3 628 000 kg).

Where more than one plant is simultaneously producing material for the job, the lot sizes shall apply separately for each plant.

(1) Mat Density. The lot shall be divided into four equal sublots. One core of finished, compacted materials shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D 3665. Cores shall not be taken closer than one foot from a transverse or longitudinal joint.

(2) Joint Density. The lot shall be divided into four equal sublots. One core of finished, compacted materials shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D 3665. Edge of cores will be taken within 6 inches of the joint of the same lot material but not directly on the joint.

(3) Sampling. Samples shall be neatly cut with a core drill. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be five inches. Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled in a manner acceptable to the Engineer and within one day after sampling.

(4) Testing. The bulk specific gravity of each cored sample will be measured by the Engineer in accordance with ASTM D 2726 or ASTM D 1188, whichever is applicable. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each sublot sample by the average bulk specific gravity of all laboratory prepared specimens for the lot, as determined as follows:

(a) Sufficient material for preparation of test specimens for all testing will be sampled by the Engineer on a random basis, in accordance with the procedures contained in ASTM D 3665. One set of laboratory compacted specimens will be prepared for each sublot in accordance with ASTM D 1559, at the number of blows required by paragraph 403-3.2, Table 1. Each set of laboratory compacted specimens will consist of three test portions prepared from the same sample increment. The sample of bituminous mixture may be put in a covered metal tin and placed in an oven for not less than 30 minutes or more than 60 minutes to stabilize to compaction temperature. The compaction temperature of the specimens shall be as specified in the job mix formula.

(b) The bulk specific gravity of each test specimen shall be measured by the Engineer in accordance with ASTM D 2726 using the procedure for laboratory-prepared thoroughly dry specimens, or ASTM D 1188, whichever is applicable, for use in computing pavement density.

(c) The bulk specific gravity used to determine the joint density at joints formed between different lots shall be the lowest of the bulk specific gravity values from the two different lots.

(5) Acceptance. Acceptance of field placed material for mat and joint density will be determined by the Engineer in accordance with the requirements of paragraph 403-5.2b.

d. Partial Lots — Field Placed Material. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Engineer agree in writing to allow overages or other minor tonnage placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

The last batch produced where production is halted will be sampled, and its properties shall be considered as representative of the particular sublot from which it was taken. In addition, an agreed to minor placement will be sampled, and its properties shall be considered as representative of the particular sublot from which it was taken. Where three sublots are produced, they shall constitute a lot. Where one or two sublots are produced, they shall be incorporated into the next lot, and the total number of sublots shall be used in the acceptance plan calculation, i.e., n

= 5 or n = 6, for example. Partial lots at the end of asphalt production on the project shall be included with the previous lot.

403-5.2 ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the bituminous mixture and completed pavement and test results:

(1) Mat density
(2) Joint density
(3) Thickness
(4) Smoothness
(5) Grade

Mat density will be evaluated for acceptance in accordance with paragraph 403-5.2b(1). Joint density will be evaluated for acceptance in accordance with paragraph 403-5.2b(2).

Thickness will be evaluated by the Engineer for compliance in accordance with paragraph 403-5.2b(3). Acceptance for smoothness will be based on the criteria contained in paragraph 403-5.2b(4). Acceptance for grade will be based on the criteria contained in paragraph 403-5.2b(5).

The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of bituminous mixture which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. Acceptance Criteria.

(1) Mat Density. Acceptance of each lot of plant produced material for mat density shall be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 96 percent, the lot shall be acceptable. If the average mat density of the lot is below 96 percent, the lot shall be removed and replaced at the Contractor's expense.

(2) Joint Density. Acceptance of each lot of plant produced material for joint density shall be based on the average of all of the joint densities taken from the sublots. If the average joint density of the lot so established equals or exceeds 94 percent, the lot shall be acceptable. If the average joint density of the lot is less than 94 percent, the Contractor shall stop production and evaluate the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.

(3) Thickness. Thickness of each course shall be evaluated by the Engineer for compliance to the requirements shown on the plans. Measurements of thickness shall be made by the Engineer using the cores extracted for each sublot for density measurement. The maximum allowable deficiency at any point shall not be more than ¼ inch less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, shall not be less than the indicated thickness. Where thickness deficiency exceeds the specified tolerances, the lot or sublot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the Engineer to circumscribe the deficient area.

(4) Smoothness. The final surface shall be free from roller marks. The finished surfaces of each course of the pavement, except the finished surface of the final surface course, shall not vary more than ⅜ inch when evaluated with a 16 foot straightedge. The finished surface of the final surface course shall not vary more than ¼ inch when evaluated with a 16 foot straightedge. The lot size shall be [ ] square yards (square meters). Smoothness measurements shall be made at 50 foot intervals and as determined by the Engineer. In the longitudinal direction, a smoothness reading shall be made at the center of each paving lane. In the transverse direction, smoothness readings shall be made continuously across the full width of the pavement. However, transverse smoothness readings shall not be made across designed grade changes. At warped transition areas, straightedge position shall be adjusted to measure surface smoothness and not design grade transitions. When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the course in accordance with the limitations noted above.

* *

The Engineer shall specify the lot size. A minimum of 2,000 square yards (1 650 square meters) is recommended.

* *

(5) Grade. The finished surface of the pavement shall not vary from the gradeline elevations and cross sections shown on the plans by more than ½ inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs which shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be [ ] square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ inch or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yards. Areas in excess of 15 square yards will require removal and replacement of the pavement in accordance with the limitations noted above.

* *

A minimum of 2,000 square yards (1 650 square meters) is recommended.

* *

403-5.3 RESAMPLING PAVEMENT FOR MAT DENSITY.

a. General. Resampling of a lot of pavement will only be allowed for mat density and then, only if the Contractor requests same in writing, within 48 hours after receiving the written test results from the Engineer. A retest will consist of all the sampling and testing procedures contained in paragraphs 403-5.1b(1). Only one resampling per lot will be permitted.

(1) A redefined mat density shall be calculated for the resampled lot. The number of tests used to calculate the redefined mat density shall include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

b. Payment for Resampled Lots. The redefined mat density for a resampled lot shall be used to evaluate the acceptance of that lot in accordance with Paragraph 403-5.2.

b. Outliers. If the tests within a lot include a very large or a very small value which appears to be outside the normal limits of variation, check for an outlier in accordance with ASTM E 178, at a significance level of 5 percent, to determine if this value should be discarded.

[403-5.4 LEVELING COURSE. Any course used for truing and leveling shall meet the requirements of paragraph 403-3.2, but shall not be subject to the density requirements of paragraph 403-5.1. The leveling course shall be compacted with the same effort used to achieve density of the test section. The truing and leveling course shall not exceed a nominal thickness of 1-½ inches (37.5 mm). The leveling course is the first variable thickness lift of an overlay placed prior to subsequent courses.**]**

* *

Use this paragraph only when there is a need to restore proper cross-section prior to overlaying. Areas of the pavement requiring a leveling course shall be shown on the plans.

* *

CONTRACTOR QUALITY CONTROL

403-6.1 GENERAL. The Contractor shall perform quality control sampling, testing, and inspection during all phases of the work and shall perform them at a rate sufficient to ensure that the work conforms to the contract requirements, and at minimum test frequencies required by paragraph 403-6.3, including but not limited to:

a. Mix Design
b. Aggregate Grading
c. Quality of Materials
d. Stockpile Management
e. Proportioning
f. Mixing and Transportation
g. Placing and Finishing
h. Joints
i. Compaction
j. Surface smoothness

403-6.2 TESTING LABORATORY. The Contractor shall provide a fully equipped asphalt laboratory meeting the requirements of paragraph 403-3.5 and 403-4.2a(2) located at the plant or job site. The Contractor shall provide the Engineer with certification stating that all of the testing equipment to be used is properly calibrated and will meet the specifications applicable for the specified test procedures.

403-6.3 QUALITY CONTROL TESTING. The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved Quality Control Program. The testing program shall include, but not necessarily limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness.

a. Asphalt Content. A minimum of two extraction tests shall be performed per lot in accordance with ASTM D 2172 for determination of asphalt content. The weight of ash portion of the extraction test, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture. The asphalt content for the lot will be determined by averaging the test results.

The use of the nuclear method for determining asphalt content in accordance with ASTM D 4125 is permitted, provided that it is calibrated for the specific mix being used.

b. Gradation. Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D 5444 and ASTM C 136 (Dry Sieve). When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix or continuous mix plants, and tested in accordance with ASTM C 136 (dry sieve) using actual batch weights to determine the combined aggregate gradation of the mixture.

c. Moisture Content of Aggregate. The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C 566.

d. Moisture Content of Mixture. The moisture content of the mixture shall be determined once per lot in accordance with ASTM D 1461 **[**or AASHTO T110**]**.

* *

ASTM D 1461 may be replaced with an AASHTO moisture content testing procedure using a conventional oven or microwave. The frequency can also change in the specification depending on the probability of incurring a moisture problem.

* *

e. Temperatures. Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the bitumen in the storage tank, the mixture at the plant, and the mixture at the job site.

f. In-Place Density Monitoring. The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D 2950.

g. Additional Testing. Any additional testing that the Contractor deems necessary to control the process may be performed at the Contractor's option.

h. Monitoring. The Engineer reserves the right to monitor any or all of the above testing.

403-6.4 SAMPLING. When directed by the Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

403-6.5 CONTROL CHARTS. The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation and asphalt content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the Engineer may suspend production or acceptance of the material.

a. Individual Measurements. Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation and asphalt content. The control charts shall use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

CONTROL CHART LIMITS FOR INDIVIDUAL MEASUREMENTS		
Sieve	Action Limit	Suspension Limit
¾ inch (19.0 mm)	0%	0%
½ inch (12.5 mm)	+/-6%	+/-9%
⅜ inch (9.5 mm)	+/-6%	+/-9%
No. 4 (4.75 mm)	+/-6%	+/-9%
No. 16 (1.18 mm)	+/-5%	+/-7.5%
No. 50 (0.30 mm)	+/-3%	+/-4.5%
No. 200 (0.075 mm)	+/-2%	+/-3%
Asphalt Content	+/-0.45%	+/-0.70%

b. Range. Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

CONTROL CHART LIMITS BASED ON RANGE (Based on n = 2)	
Sieve	Suspension Limit
½ inch (12.5 mm)	11 percent
⅜ inch (9.5 mm)	11 percent
No. 4 (4.75 mm)	11 percent
No. 16 (1.18 mm)	9 percent
No. 50 (0.30 mm)	6 percent
No. 200 (0.075 mm)	3.5 percent
Asphalt Content	0.8 percent

c. Corrective Action. The Quality Control Plan shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

(1) One point falls outside the Suspension Limit line for individual measurements or range; or

(2) Two points in a row fall outside the Action Limit line for individual measurements.

* *

The aggregate control chart parameters and Suspension and Action Limits contained in the above paragraphs are based on ¾ inch (19.0 mm) maximum size aggregate gradation. When 1-inch (25.0 mm) or 1-¼ inch (31.2 mm) maximum size aggregate greater than ¾" is specified, the Individual Measurements Chart requirements should be amended as follows:

Sieve	Action Limit	Suspension Limit
1 inch or greater or 1-½ inch	0%	0%
¾ inch	26%	11%

When ½-inch (12.5 mm) maximum size aggregate is specified, the ¾-inch (19.0 mm) and 1-inch (25.0 mm) sieves should be deleted from the Individual Measurements Chart and the ½-inch (12.5 mm) sieve Action and Suspension Limits should be changed to 0%. For the ½-inch (12.5 mm) gradation, the ½-inch sieve should be deleted from the Range Chart.

* *

403-6.6 QUALITY CONTROL REPORTS. The Contractor shall maintain records and shall submit reports of quality control activities daily.

METHOD OF MEASUREMENT

403-7.1 MEASUREMENT. Plant mix bituminous concrete pavement shall be measured by the number of tons (kg) of bituminous mixture used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

BASIS OF PAYMENT

403-8.1 PAYMENT. Payment for an accepted lot of bituminous concrete pavement shall be made at the contract unit price per ton (kg) for bituminous mixture**.** The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-403-8.1a	Bituminous **[ ] [**Surface**] [**Base**] [**Binder**] [**Leveling**]** Course -- per ton (kg)

TESTING REQUIREMENTS

ASTM C 29	Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C 88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	Materials Finer than 75-um (No.200) Sieve in Mineral Aggregates by Washing
ASTM C 127	Specific Gravity and Absorption of Coarse Aggregate
ASTM C 131	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 566	Total Evaporable Moisture Content of Aggregate by Drying
ASTM D 75	Sampling Aggregates
ASTM D 979	Sampling Bituminous Paving Mixtures
ASTM D 995	Mixing Plants for Hot-Mixed Hot-Laid Bituminous Paving Mixtures
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1074	Compressive Strength of Bituminous Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1461	Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1559	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2419	Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2489	Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D 2950	Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D 3203	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D 3665	Random Sampling of Construction Materials
ASTM D 3666	Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D 4125	Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D 4867	Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	Standard Test Method For Mechanical Size Analysis of Extracted Aggregate
ASTM D 5581	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6" Diameter Specimen)
ASTM E 11	Wire-Cloth Sieves for Testing Purposes
ASTM E 178	Dealing with Outlying Observations
AASHTO T 30	Mechanical Analysis of Extracted Aggregate
[AASHTO T 110	Moisture or Volatile Distillates in Bituminous Paving Mixtures**]**
The Asphalt Institute's Manual No. 2 (MS-2)	Mix Design Methods for Asphalt Concrete

MATERIAL REQUIREMENTS

ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 946	Penetration Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 4552	Classifying Hot-Mix Recycling Agents
AASHTO MP1	Performance Graded Binder Designation

END OF ITEM P-403